search arrives at more positive results, indicating a different origin for +. He shows that in Widman's printed arithmetic of 1489, + had not yet become a purely mathematical sign, that with Widman + meant simply "und" (and), in conformity with a practise of the middle ages, according to which a symbol closely resembling + was used for "et."[3] It is now known that Widman possessed a manuscript algebra in which + is used for "et," even in cases where "et" does not mean addition.[4] Widman in 1849 sometimes indicated subtraction by the special symbol —, a usage found somewhat earlier in a Dresden manuscript of the year 1481.

Halsted attributes decimal fractions to Stevin (1585), but makes no mention of the earlier use of decimals by Vieta[5] (1579) and Rudolff[6] (1530). Halsted mentions Napier (1617) as the first to use the decimal point, but the period (or the comma) was used by Bürgi as early as 1592,[7] by Prätorius in 1599[8] and by Kepler in 1616.

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Treatise on Light. By CHRISTIAAN HUYGENS. Rendered into English by SILVANUS P. THOMPSON. London, Macmillan & Company. 1912. Pp. vii+128.

Ever since its birth, in 1690, the wave theory of light has been adapting itself to environment. Just at the present moment, when the completeness and perhaps the competency of the wave theory is being called in question by certain phenomena of radiation and radioactivity,[1] an English translation of Huygens's great "Treatise on Light" is particularly opportune. The fact that this translation has been made by Professor Silvanus P. Thompson is an ample guarantee that it has been done in a scholarly and sympathetic manner. Two distinct courses are open to one who wishes to transfer into English the thought of a foreign author who lived more than two hundred years ago—either he may employ the English phraseology of our own day, or he may use that which he conceives to have been the current diction of the period in which the work was composed. In either case he must avoid anachronisms, and in either case the problem is difficult. So many modes of expression are common to the languages of western civilization and so many of these forms have disappeared from our language during the last two hundred years, that a certain quaintness is inevitably given to any translation of old French, German, or Italian, in which particular pains is not taken to avoid these obsolete phrases. It is the second of these alternatives which Professor Thompson has chosen. The result is that the volume including its title page, table of contents, text, paper, binding, typography, size, and English style, is as nearly as possible what it would have been if Huygens had lived and worked and published on the other side of the English Channel. This is not to be understood as meaning that the translation is in any sense a literal one, for it is precisely the spirit of the work which Professor Thompson has caught and has faithfully reproduced. In brief the volume is in every way worthy of the great contributions to science which it contains. The first three chapters in which Huygens's principle is enunciated had already been made available to English readers through *Harper's Scientific Memoirs*. But the full evidence for Huygens's principle can only be obtained by understanding Chapters 4, 5 and 6. Atmospheric refraction is explained in Chapter 4 practically as we have it to-day. In Chapter 5 the wave sur-

[3] *Bibliotheca mathematica,* 3 F., Bd. 9, 1908–09, pp. 155–157, 248.

[4] *Bibliotheca mathematica,* 3 F., Bd. 10, 1909–10, p. 182, 183.

[5] *Bibliotheca mathematica,* 3 F., Bd. 11, 1911, p. 340.

[6] *Bibliotheca mathematica,* 3 F., Bd. 10, 1909–10, p. 243.

[7] *Teachers College Bulletin,* 1910–11, No. 5, p. 19.

[8] Cantor, *op. cit.,* Vol. II. (2), 1900, p. 619.

[1] W. H. Bragg, evening discourse before the British Association at Dundee, *Nature,* 90: 559 (1913); R. A. Millikan, vice-presidential address before the American Association for the Advancement of Science, *Science,* January, 1913.

face is worked out for Iceland spar. Here it is shown how a ray may fall obliquely upon a plane surface without suffering refraction. Here too is set forth the invention of the ellipsoidal wave surface to explain refraction in uniaxial crystals—one of the cleverest chapters in the entire history of science. The sixth chapter is given over to "the figures of transparent bodies which serve for refraction and for reflection." Here the principle of "equivalent optical paths" is employed with its well-known elegance. The thanks of all students of optics are due to both translator and publisher for this complete and accurate rendition of a memoir which has long been so rare and expensive as to be practically out of reach of the ordinary reader.

H. C.

SPECIAL ARTICLES

THE HISTORY OF LOST RIVER

IN a previous paper written over a year ago and published by the Society for Protection of New Hampshire Forests, in their annual report for 1911, I tried to solve the problem which Lost River presents. Since that time I have made several visits to Kinsman Notch and have each time found new evidence on which to base conclusions. The following paper is offered as a further attempt at an explanation, based on the new evidence.

Lost River is a small stream rising in Kinsman Notch, about seven miles in a westerly direction from North Woodstock, New Hampshire.

The spectacle which presents itself on entering the river is very confusing. The river is immediately lost to view among a mass of huge granite blocks, some of them as large as average dwelling houses. Large potholes are numerous, as well as many beautifully curved water channels. Many of the potholes are fractured and fragments of these lie in the general mass. By careful inspection it is seen that this is an old rock gorge, and that something violent has taken place. Many joint blocks have fallen in, making it impossible to follow the water of the river in its course without ladders and bridges. The Society for Protection of New Hampshire Forests, has purchased 148 acres, including the Lost River and the overhanging cliff, and has placed ladders and bridges in the gorge, so it is no longer difficult to see all the interesting points. There are two sets of caverns (so called because of large vacant spaces between the joint blocks), an upper and a lower. The upper caverns are about one quarter of a mile long. The stream emerges from these at Paradise Falls, flows unobstructed for about 150 feet, and plunges again beneath another mass of joint blocks, the lower caverns. The latter are not so imposing nor as extensive, although very interesting.

In contemplating this heap of granite blocks with the purpose of finding an explanation to the riddle, there are three agents which present themselves as seemingly capable of bringing about such confusion: frost action on a large scale; the disruptive force of a moving glacier; and earthquake action.

There has been considerable frost action in the gorge, and without doubt many blocks have been slowly wedged apart and fallen down from the sides of the gorge. That frost action, however, does not account for all the falling and movement, is to me quite evident. When in the lowest caverns one finds cases where blocks which have slipped from between other huge blocks in place, have left the upper and lower blocks entirely unmoved in the solid ledge. Smooth slickenside-like patches give evidence of a rapid and violent movement. This does not resemble frost action. The fearful confusion and pell-mell attitude of the mass also bespeak something more than the gradual work of frost.

The disruptive force of a moving glacier would seem at first glance capable of creating such a confused mass of joint blocks. It could not account, however, for the movements below the solid ledge, as described above. In one case I found a movement in a lateral direction between two blocks. The lower one is evidently in place and a part of the solid ledge, and the upper one has moved against the direction of movement of the ice about four inches. If ice were accountable for the slip,